

Strengthening the potato seed system in Georgia: preliminary results

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Abstract

Potato is one of Georgia's major staple and cash crops. The area under potato cultivation varies between 30 000 and 35 000 ha per year, but productivity still remains very low. In fact, with a potato yield ranging from 8.9 to 12 t/ha (average data over the last ten years), Georgia is in the group of low yield countries, the yield being only 3-4 times higher than the seed rate. Poor seed quality is one of the main reasons for low production, which became more acute following the collapse of the Soviet Union and consequent disruption of seed production and trade. The other reasons are late blight (*Phytophthora infestans*), not well-adapted cultivars and poor husbandry practices at farmer level. The International Potato Center (CIP), with the help of local scientists and advisors, is working to improve the informal seed potato system in the country. Here new plans are reported for establishing quality control mechanisms to better guarantee reasonable good quality seed from informal seed producers for purchase by ware potato growers.

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INTRODUCTION

Background

In Georgia, the potato cultivated area has increased from 21 900 ha in 1992 to about 30 100 ha in 2007, showing growth of 37.4 percent in 16 years. About half of the potato area is under irrigation. Statistics of the Ministry of Agriculture (Republican Statistical Committee of the Republic of Georgia) report that the main areas of potato cultivation are concentrated in the regions of Samtskhe-Javakheti (12 663 ha), Kvemo Kartli (9 819 ha), Kakheti (4 038 ha), Mtskheta-Mtianeti (2 424 ha) and Shida Kartli (1 834 ha). Potato yield varies considerably from region to region, ranging from 4.5 t/ha of Samegrelo and Zemo Sva regions to 16.3 t/ha of Samtskhe-Javakheti.

Excellent opportunities for seed potato production exist in Akhalkalaki, Tsalka, Bogdanovka, Akhalsikhe, Dmanisi, Mestiisk and other mountainous districts. There are also favorable conditions in Dusheti and Tianeti districts, as well as Svanetti, Racha-Lechumi, and the mountain areas of Adjara. However, these regions do not have organized seed potato production systems. Recently, a few Seed Growers' Associations or Cooperatives were informally organized by individual farmers with the assistance of a few NGOs (Mercy Corps, CARE International, International Association of Agricultural Development [IAAD]), and have been set up under CIP's close supervision. Although they present considerable potential for development, these examples are isolated and lack access to improved technologies such as adapted cultivars and crop management practices, disease detection and appropriate storage infrastructure.

Predominant potato cultivars; pest and disease problems

About 18 potato cultivars are grown in Georgia. The most important ones are: Impala (very early), Marfona (mid-early), Picasso (mid-early), Sante (mid-early), Cosmos (mid-late), Desiree (late), Agria (late), Felicitas (early), Marabel (mid-early), Palma (mid-early), Solara (mid-early) and Clarissa (mid maturing). Preferences are for white skin and early or mid-early cultivars.

The most important diseases affecting potato crops include viruses (PVY, PVX) that contribute to poor seed quality, other pathogens like *Erwinia* spp., *Rhizoctonia solani*, and especially *Phytophthora infestans*. It is not rare to see blight-affected plants as well as tubers showing blight at harvesting. Frost, to which most of the cultivars appear very sensitive, is also common during

the months of May and June. The Colorado potato beetle (*Leptinotarsa decemlineata*, Say) is present in the lowlands and in the highlands up to 1 800-2 000 m.a.s.l. By dressing seed tubers before planting with Prestige (a.i.: *imidacloprid*, 140 g/l/ton of seed), farmers limit the damages to an acceptable level. Although banned in some countries due to its deleterious environmental effects with massive loss of bee colonies (Bonmatin et al., 2005), this active ingredient is heavily used by farmers all over Central Asia and the Caucasus under different brand names (Confidor, Gaucho, Prestige).

Among the potato cultivars under cultivation in Georgia there is little resistance to late blight (*Phytophthora inf.*, Bary), which has led to intensive spraying of chemicals (systemic plus contact fungicides) and consequently increasing risks due to health and environmental hazards in a country rich in spas and mineral water resources. Late blight is particularly virulent in the months of July-August when airstreams from the mainland and the Black Sea often come across with consequent rainfall and severe late blight infection (Chumakov and Zakharova, 1990).

Current technology of potato production and storage

In the highlands, the main potato areas are located in two regions, Mesgeti (Aspindze, Akhalsikhe, Adigeni districts) and Javageti (Akhalkalaki, Ninotsminda, Tsalka districts) with planting in April-May and harvesting in September-October. In the lowlands, potato is mainly cultivated in the districts of Kardabani, Marneuli, Bolnisi from February to May-June and sometimes from July till October.

Hand labor is a normal practice occasionally assisted by small mechanization, but there are also cases of intense mechanization practices in large fields. Furrow irrigation is sometimes very roughly practiced without proper control of water flow, which leads to collapse of ridges and consequent tuber blight attacks on tubers being exposed to atmospheric agents and pathogens.

Potatoes are mainly cultivated by smallholders. There are about 656 000 farm holdings in Georgia with an average size of about 1.25 ha distributed in scattered parcels of land (Republican Statistical Committee of the Republic of Georgia). Due to the small size of farm holdings, it is very difficult to apply suitable rotational patterns. Some farmers try to solve the problem by renting land from the village municipality or neighbors. Neglecting crop rotation has brought soil infestation by nematodes (*Globodera pallida* and *G. rostochiensis*) in very restricted areas of Akhalkalaki district, for instance (Chkhubianishvili et al., 2008). Unfortunately, there is an increasing trend to shift to monocropping patterns with wheat and potato being the most important crops in the lowlands and highlands, respectively.

Important potato seed production practices such as isolation, crop rotation, roguing, haulm killing and sanitary management of the seed crop are not perceived as important while cultural practices such as seed-bed preparation, pre-sprouting, ridging and weed control within and around the fields are applied little or not at all. Moreover, farmers' knowledge of farm management, planning, budgeting, and record keeping is still basic.

Most farmers use locally available barns or cellars as storage facilities for potatoes. Although some of the structures present good insulation from frost, ventilation still needs to be improved since storage losses due to condensation have been estimated at about 20-30% (IFAD, 2004).

Prior and on-going assistance to the seed potato sector

Since 1989 the country has been suffering a major economic crisis due to domestic political conflicts and the breakdown of the former Soviet Union. Frequent wars, the unstable political situation and the agricultural policy of the former Soviet Union have destroyed much of the country's indigenous biodiversity and have led to shortages in food production. This situation opened the door for the import of seed potatoes from western countries. Seed tubers of Dutch and German origin (class E and A) are imported every year and multiplied locally for three or four generations by a group of seed growers assisted by NGOs, EU and UN agencies. Small amounts of seed of dubious quality are also supplied by neighboring countries.

To complicate the picture, no official seed certification system is applied. The old seed legislation has been suppressed and the new one is waiting to be promulgated by Parliament. The most relevant laws for seed production are: "Concerning the Authorization of Multiplying Seed and other Planting Materials and Breeding," promulgated 25 June 1999, and "On Protection of New Species of Plants", promulgated 29 December 2006 (D. Bedoshvili, CYMMIT, personal communication).

At present local seed multipliers struggle to obtain healthy planting materials since the value of European currency has gone up, importing Elite class seed potatoes from Holland or Germany is prohibitively expensive. Too often, in order to save on costs, they import seed potatoes in non-refrigerated trucks resulting in the seed tubers losing energy due to over-sprouting. Once planted, those seed potatoes often react with the formation of "little potatoes", which is typical of seed under physiologically old conditions.

As a consequence, farmers tend to utilize their own seed saved for several generations making for declining potato yields year after year due to the degenerating effects of virus diseases. In order

to radically improve the situation in the potato production sector, there are two options. The first would be to develop a sustainable seed potato certification system for adapted, virus- and late blight-resistant cultivars, aimed at reducing dependence on external sources of seed, thus improving the livelihood of rural populations of the mountainous areas of Georgia. This would, however, require the presence of an efficient research and extension system that is, unfortunately, seriously lacking in Georgia. Alternatively, the existing informal seed potato production system may be improved through specialized training of farmers in seed quality management for prevention of soil- and seed-borne diseases.

CIP'S INTERVENTIONS: PRELIMINARY RESULTS

Improvement of informal seed potato production system in Georgia

From 2005 to 2008, CIP, together with a local NGO first called International Mountain Agriculture Development (MADI) and then the International Association for Agriculture Development (IAAD), has developed a methodology for training potato growers in seed quality management. In the training, potato growers learned how to maintain the quality of potato seed through the application of positive and negative selection. Consequently, farmers became aware of potato diseases, the impact that seed potato quality can have on yield, the importance of using high quality seed, and the need for regular replenishment of seed stock with high quality seed from specialized seed growers. Documentation has been translated into the Georgian language and distributed to farmers by CIP's partners.

With the help of IAAD and international NGOs like Mercy Corps more than a hundred seed potato multipliers have been trained in the three districts of Akhalkalaki, Aspindza and Akhalsikhe. As far as Akhalkalaki district is concerned, training was supported by the EU project called "Integrated Program of Poverty Reduction" whose aim was to enhance livelihoods of farmers, among them an important community of Armenian refugees.

In 2007, CIP, in collaboration with local partners assisted 45 farmers who cultivated about 17 hectares with Elite class seed of five potato varieties (Agria, Marfona, Kondor, Picasso and Amorosa) purchased from the Dutch seed company AGRICO with the financial support of the European Union. From the initial amount of 50 tons of Elite class seed, 528 tons of potatoes were harvested. Due to the high quality of seed planted and the relative absence of serious diseases to justify positive selection, farmers practiced roguing or negative selection. At harvest, tuber size distribution of the five cultivars was reported according to the graph below.

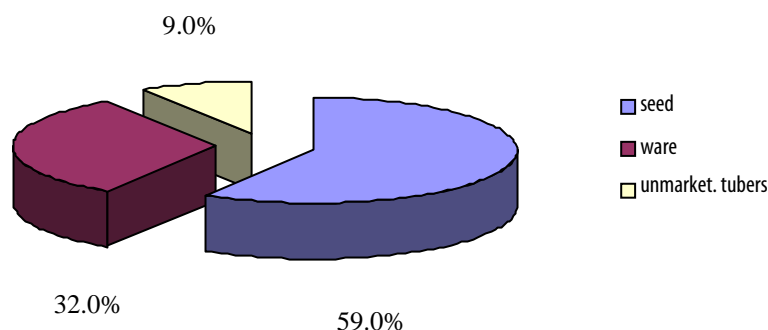


Figure 1.
Distribution of
harvested tubers by
size (%), 2007

As the percentage of seed-sized tubers was only 59%, despite the normal average of 70% (Kempenaar, 2007) considered optimum in seed potato production, farmers received training in spring 2008 to improve previous results. Training therefore included topics such as: (i) increasing planting density; (ii) adopting a specific fertilization formula giving priority to P rather than N or K; and (iii) practicing timely haulm killing.

In 2008, other farmers joined the operation for a total of 108 potato growers, who were members of 8 Cooperatives present in the Akhalkalaki district. The amount of supposed class A seed, issued from previous multiplication of imported seed, varied from 0.4 to 1.06 tons per farmer for an area ranging from 0.11 to 0.3 ha per plot, at a planting rate of 3.5 tons of seed potato per hectare, that is a planting density of 66 000 plants per hectare and a planting distance of 0.75 x 0.20 m. In two villages, demonstration trials were established and run by members of the cooperatives where positive and negative selection plus main husbandry practices were regularly carried out to show the importance and timely application of improved technology. Akhalkalaki district is entirely located on a plateau covering about 6 500 square kilometers, at an altitude varying from 1 600 to 1 900 meters (Elizbarashvili et al., 2006). The climate is continental, with long winters and warm summers and partially dry with rainfall occurring occasionally in July and more frequently in August and September. Soil belongs to “chernozem”, or black soil, of mountain-meadow type (Ibid.). C/N is about 4.5 to 5.1% with the Nitrogen content varying from 8 to 10 mg/100 g of soil, Phosphorus from 10 to 12 mg and Potassium from 35 to 40 mg. Soil pH is about 5.9, which is ideal for potato cultivation. Planting was done between 2 and 12 May and harvest was completed in 15 days, from 20 September till 05 October.

Establishing a quality control system

The idea was to gradually introduce a quality control system suitable for adoption under the particular conditions of Georgia, where an official organized seed production system is lacking, and to create conditions that will allow specialized seed growers to sell reasonably high quality seed at a premium price to compensate the best growers for their improved efforts.

In order to detect the amount of potato viruses present in class A seed potatoes under multiplication, the ELISA test was conducted on potato leaflets collected from 12 fields (see Table 1) on 22 and 23 August 2008. The dramatic events of August 2008 made it difficult to widen collection in order to include other growers. In total, 240 samples (20 samples collected in 12 fields) per virus tested were randomly distributed on 3 plates, with 80 wells filled per plate. Since the ELISA test was conducted on 6 viruses (PLRV, PVY, PVX, PVS, PVM and PVA), in total 18 plates were utilized. In this task, a local virologist was assisted by the staff of the NGO IAAD. In the field,

sampling was done by collecting potato leaflets from 80 plants chosen at random on a diagonal transect across the field and bulked to have a sample consisting of 4 leaflets per bag, resulting in 20 samples per field, which, multiplied by 12 fields, gave a total of 240 samples collected per virus. Elisa test was conducted in the Laboratory of the Bioorganic Chemistry Dept. of Tbilisi State University on 24–28 August by the virologist and a laboratory assistant, using DAS-ELISA¹ kits supplied by CIP-Lima. Results were analyzed with the support of the Elisa-reader State-Fax-2100 (Company AWARENESS TECHNOLOGY) in the laboratory.

According to the virologist, results are a perfect reflection of reality with the most widespread virus, PVY, present in ten out of 12 samples, followed by PVX, PVA and PVS. PLRV and PVM were absent in all the tested samples. In fact, observations conducted in the country in the last ten years and further laboratory analysis revealed that the most frequent potato viruses are potato leaf drop streak, severe and rugose mosaic, crinkled mosaic caused by Potato Virus Y (PVY), potato mild mosaic and spotted mosaic caused by Potato Virus X (PVX).

The most productive variety (47.8 t/ha) was Kondor, followed by Agria (43.2 t/ha), while the lowest productivity was obtained with Amorosa (11.6 t/ha). In total, about 700 tons of potatoes were harvested, out of which 120 tons (17.0%) were of a caliber above 55 mm, while the seed fraction (25-55 mm) and the unmarketable seed (<25 mm) corresponded to 512.2 (73.3%) and 67.0 tons (9.6%), respectively (Figure 2).

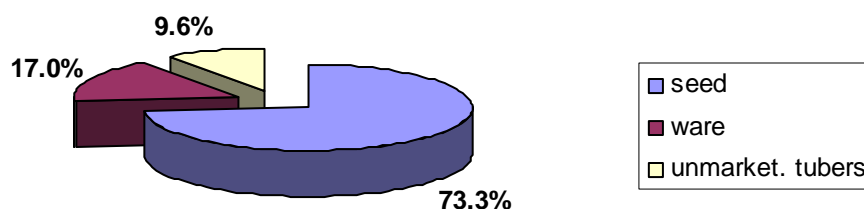


Figure 2.
Distribution of
harvested tubers by
size (%), 2008.

¹ Double-Antibody Sandwich (DAS) method of the Enzyme-Linked Immunosorbent Assay (ELISA).

PRELIMINARY TOPICS FOR INTERVENTION IN THE FUTURE

Improving the farmer-based seed potato production system

Producing and distributing seed potatoes is an expensive and technologically challenging enterprise. One single seed potato that is planted gives roughly 6 to 10 seed potatoes at harvest, which makes bulking of high quality seed costly and time consuming. During multiplication the quality of seed potatoes declines because it gets infected over generations with virus diseases that are transferred through seed.

In Georgia, CIP's assistance so far has been concentrated on seed potato growers, but to improve seed potato quality, what is called Farmers' Saved Seed (FSS), produced by ware potato growers, should also be considered. By continually improving seed management, ware potato growers should be able to recycle potatoes from their own harvest as seed, which could have an important impact by leading to the maintenance of acceptable yield levels (Gildemacher et al., 2007).

Table 1. Results of the ELISA-test

#	Village/ Cooperative	Variety	Area (ha)	Number of samples	Virus infection														
					PVM		PVS		PVX		PLRV		PVY		PVA		Total:		
					Positive samples	%	Positive samples	%	Positive samples	%	Positive samples	%	Positive samples	%	Positive samples	%	Amount of samples	Positive samples	%
1	Kotelia, Coop. "Azmana"	Agria	1.0	20	0	0	0	0	10	50	0	0	6	30	0	0	120	16	13
2	Olaverdi Coop. "7 karo"	Marfona	2.0	20	0	0	0	0	4	20	0	0	6	30	0	0	120	10	8.3
3	Diliska, Coop. "Chobareti"	Picasso	1.1	20	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0
4	Kotelia, Agro-Cartu	Agria	3.5	20	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0
5	Kotelia, Agro-Cartu	Marfona	1.6	20	0	0	0	0	0	0	0	0	5	25	0	0	120	5	4.2
6	Baraleti, Coop. "Kulikami"	Picasso	1.2	20	0	0	0	0	0	0	0	0	17	85	0	0	120	17	14
7	Kotelia, Service-center	Marfona	3.3	20	0	0	0	0	0	0	0	0	16	80	0	0	120	16	13
8	Airport, Coop. "Kulgumo"	Agria	1.2	20	0	0	1	5	0	0	0	0	6	30	3	15	120	10	13
9	Gogasheni, Coop. "Eko-Aisi"	Marfona	1.2	20	0	0	0	0	0	0	0	0	1	5	0	0	120	1	0.8
10	Baraleti, Coop. "Chobareti"	Agria	1.2	20	0	0	0	0	0	0	0	0	1	5	0	0	120	1	0.8
11	Baraleti, Coop. "Djavaxeti"	Marfona	3.3	20	0	0	0	0	0	0	0	0	16	80	0	0	120	16	13
12	Alastani, Coop. "Chobareti"	Marfona	1.0	16	0	0	0	0	0	0	0	0	14	65	0	0	96	14	15

In addition, the strategy would promote specialized motivated potato farmers into seed multipliers selected in appropriate districts to becoming members of the new Seed Potato Growers' Association. They will be trained and receive technical assistance from local partners. Priority should be given to larger farms that will be monitored to become members, as these are more likely to make the investments required for optimal production and have enough land for rotation. Initial investments will have to be provided by the farmers themselves. Large farmers with more than 0.5 ha of potato fields refuse, however, to apply positive selection because they argue that it is difficult to keep wooden stakes in the field when spraying has to be done with tractor and mounted sprayer.

CIP and local partners, under the auspices of the Ministry of Agriculture, should assist in the implementation of simple diagnostic methods to test the quality of seed produced by the Association, which formerly received basic seed imported from Europe. Waiting for the establishment of an informal certification system, seed quality control should be preliminarily organized by the Association itself through an internal inspection system also consisting of virus detection tests to permit the seed growers the possibility of selling Quality Declared Seed (Lutaladio et al., 2009), which should be labeled by the Association.

Essential for the process of introducing improved technology are demonstration experiments in which farmers compare yields by means of (i) using existing seed selection methods, (ii) applying positive and negative selection, and (iii) purchasing seed from specialized seed growers. This provides the farmers with options to improve seed quality. They can opt for positive and negative selection, which on average increased yields in Kenya by 28% without financial investment after putting it into practice for a single season (Gildemacher et al., 2007). Or they can choose to purchase high quality imported seed, which can increase yields more dramatically, but at the same time requires heftier financial investments.

Moreover, as an additional complementary approach, opportunities for potato system improvement that could result in improved potato productivity will be investigated by diagnosing the potato system through surveys outlined by several authors (Biggs et al., 1999; Elzen and Wiczorek, 2005; Gildemacher et al., 2009) to identify key technical intervention topics and suggest options for improvement.

Linking seed and ware producers and training

To assure a ready and receptive market for seed potatoes, linkages need to be established between commercial seed potato multipliers and smallholder ware potato farmers through the

development of potato value chains (Bernet et al., 2006) that equitably share benefits among value chain actors as the recent Seed Award given to T'ikapapa demonstrates².

In the absence of a functioning seed potato certification system, as is the case right now in Georgia, building ware farmers' confidence in quality seed offered by seed multipliers is essential. The success obtained by an informal seed multiplier depends largely on his reputation to deliver constant high quality seed planting materials.

Improve ware potato farmers' awareness of seed quality management

Currently Georgian ware potato producers' awareness of seed potato quality management is limited. Improving awareness is essential for sustainable increases in potato yields. Training and demonstration of how the quality of farm-saved seed potatoes can be improved will show the importance of high quality seed potatoes and encourage ware potato producers to regularly renew seed. During the training courses, ware potato farmers will not only receive guidance on seed quality management, but also instructions on late blight control and improved husbandry practices.

CONCLUSIONS

The first objective of our approach was to increase availability of reasonably high quality seed at an affordable price. In the absence of an official seed production system run by public research institutes or private seed companies, the only possibility was intensified support for informal seed systems. By linking ware potato farmers with informal seed potato farmers, it is expected that seed potato marketing channels will be improved.

Positive selection will be further diffused among smallholder farmers, although the 75 x 20 cm planting distance makes it very difficult to apply. In fact, by utilizing an intra-row spacing greater than 20 cm, the percentage of large tubers obtained using current imported varieties is too important, thus reducing chances to sell them as seed. Experimentation should also consider the adoption of fertilization rates which take into account the fertile soil characteristics of southern Georgia.

Existing infrastructure and capacity of the national research program for production of high quality starter seed are not developed. The NARS core mandate is potato research, not cost-

² 2007. Seed Award winners: T'ikapapa: An innovative way to link Andean small-scale farmers with the new urban markets. Viewed at: <http://seedinit.org/mainpages2/awards/2007/peru.pdf?PHPSESSID=2b21d918529be7ad00b34ca488653347>.

effective seed potato production. Private sector involvement to assure business-oriented seed production is seen as the way forward to a sustainable and profitable seed potato sector. Sustainable commercial seed potato enterprises can be developed through facilitating public-private partnership and promoting commercial seed multiplication.

CIP and partner institutions intend to further develop quality control mechanisms that, in the absence of a nationally applied seed certification system, would give a certain guarantee to ware potato farmers that seed growers can provide them with seed of satisfactory quality. Such a system would represent a stimulus for seed growers to improve a product that can be sold at a superior price. A seed quality control mechanism has been tested on an experimental basis, trying to convince public officials of its relevance. Once such mechanisms become a regular practice, then their diffusion among seed potato growers will be a matter of time.

To be effective such system must be enforced by the Ministry of Agriculture, which will be asked to select informal seed potato growers based on the quality of regularly commercialized seed. This will be instrumental in brokering the necessary linkages between seed multipliers and the targeted market of ware potato producers. In fact, steady market demand is essential to assure continuity of seed potato production enterprises.

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Republican Statistical Committee of the Republic of Georgia. www.statistics.ge



CIP's Mission

The International Potato Center (CIP) works with partners to achieve food security and well-being and gender equity for poor people in root and tuber farming and food systems in the developing world. We do this through research and innovation in science, technology and capacity strengthening.

CIP's Vision

Roots and tubers improving the lives of the poor.



CIP is supported by a group of governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR).

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